UNIVERSITI PUTRA MALAYSIA

EFFECTS OF CALCIUM SALT OF PALM FATTY ACID DISTILLATE ON THE GROWTH HUMEN PARAMETERS, AND MEAT QUALITY OF SHEEP

IMAD NEMER HASSAN ALWAHEIDI.

FP 2005 17

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By

IMAD NEMER HASSAN ALWAHEIDI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

September 2005

DEDICATION

With appreciation and respect

this thesis is dedicated

to my parents,

to the people of holy land, PALESTINE.

I owe my country a great debt.

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Imad N H Alwaheidi

September 2005

Chairman: Professor Abd Razak Alimon, PhD

Faculty: Agriculture

The effects of dietary Ca-salt of palm fatty acid distillate (CSPFAD) as an energy supplement on sheep performance, carcass characteristics and meat quality were examined. Eighteen Santa Ines lambs weighing 16.6±1.4 kg were randomly allocated to three dietary treatments with six animals for each group. The lambs were fed a based diet containing palm kernel cake plus oil palm frond (PKC+OPF) supplemented with either 0% (diet 1), 2.5% (diet 2) and 5% (diet 3) calcium salt of palm fatty acid (CSPFAD). The feed intake, body weight and feed conversion ratio were recorded every two weeks for a period of 4 months. At the end of the experiment, 9 lambs (3 lambs from each dietary treatment) were randomly selected and slaughtered to examine carcass characteristics. *Longissimus dorsi* (LD) muscle were sampled and examined for cooking loss and objective tenderness by Warner-Bratzler shear force analysis. In the second experiment three adult male sheep (51 ±

2.12 kg body weight) fitted with ruminal cannulas were used, 3 x 3 Latin square design to determine the degradability of dry matter and protein at 6, 12, 24, 36 and 48 hr incubation time. The pH, ammonia nitrogen (NH_3-N) and volatile fatty acid (VFA) of the rumen fluid were measured at 0, 2 and 4hr post-feeding and stored at -20C° until analysis.

The result shows there were no significant difference ($P>0.05$) in feed intake and body weight changes of the lambs among the dietary treatments. pH, total VFA, molar proportions of acetic acid, and acetic : propionic ratio of rumen fluid were not affected by dietary treatment. However, there was significant difference ($P<0.05$) in propionic acid molar proportion between the dietary treatment with the highest and lowest indicated in the 5% (diet 3) and control (diet 1), respectively. Further more, the pH of meat, dressing percentage, and carcasses composition are similar ($P>0.05$) among the dietary treatments. However, cooking loss of meat increased ($P<0.05$) as the levels of CSPFAD was increased in the diet. Significant different ($P<0.05$) in shear force were observed between diets with highest and lowest indicated by the control and 5% dietary treatment respectively.

It can be concluded that the CSPFAD can be used up to 5% as an energy source in a diet without any adverse effects on rumen fermentation. It can also enhanced meat quality such as tenderness.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi keperluan Ijazah Sarjana Sains

KESAN BAHAN SULINGAN ASID LEMAK GARAM KALSIUM PALMA KE ATAS PERTUMBUHAN, PARAMETER RUMEN DAN KUALITI DAGING BIRI-BIRI

Oleh

Imad N H Alwaheidi

September 2005

Pengerusi: Profesor Abd Razak Alimon, PhD

Fakulti: Pertanian

Kesan tiga tahap diet bahan sulingan asid lemak garam kalsium palma (CSPFAD) sebagai tenaga tambahan ke atas prestasi biri-biri dan kualiti daging telah diperiksa. Lapan belas ekor anak biri-biri Santa Ines yang beratnya 16.6±1.4 kg telah diagihkan secara rawak kepada tiga rawatan diet dengan enam haiwan untuk setiap kumpulan. Anak biri-biri telah diberi makan diet asas mengandungi PKC dicampur OPF (PKC+OPF) diberi penambahan samaada dengan 0% (diet 1), 2.5% (diet 2) dan 5% (diet 3) CSPFAD. Pengambilan makanan, berat badan dan nisbah pertukaran makanan direkodkan setiap dua minggu untuk jangka masa 4 bulan. Pada akhir eksperimen, 9 haiwan (3 haiwan daripada setiap kumpulan diet) telah dipilih secara rawak dan disembelih untuk mengkaji ciri-ciri karkas. Otot *Longissimus dorsi* (LD) telah disampel dan diperiksa untuk ujian kehilangan masakan dan kelembutan objektif melalui analisis Warner-Bratzler shear force. Dalam eksperimen kedua, tiga

biri-biri dewasa (51 ± 2.12 kg berat badan) telah dipasang dengan kanula rumen. Teknik beg nilon dengan reka bentuk eksperimen 3 x 3 segiempat Latin telah digunakan untuk menentukan degradibiliti bahan kering, dan protein pada 6, 12, 24, 36 dan 48 jam masa inkubasi. pH, nitrogen ammonia dan asid lemak meruap dari cecair rumen telah diambil sampel pada 0, 2 dan 4 jam selepas diberi makan dan disimpan pada -20C° sehingga dianalisis.

Keputusan menunjukkan tiada perbezaan yang bererti ($P>0.05$) dalam pengambilan makanan dan perubahan berat badan anak biri-biri. Nilai pH, jumlah VFA, pembahagian molar asid asetik dan nisbah asetic propionik cecair rumen adalah tidak terkesan oleh rawatan diet. Walau bagaimanapun, terdapat perbezaan bererti ($P<0.05$) dalam asid propionik antara rawatan diet dengan yang tertinggi dan terendah ditunjukkan masing-masing dalam kumpulan 5% dan kumpula kawalan. Tambahan pula, pH, peratus daging, dan komposisi karkas adalah serupa ($P>0.05$) di antara rawatan diet. Walau bagaimanapun, kehilangan masakan daging meningkat ($P<0.05$) apabila aras CSFA meningkat di dalam diet. Perbezaan bererti ($P<0.05$) dalam shear force antara diet dengan nilai tertinggi dan terendah ditunjukkan masing-masing pada kumpulan kawalan dan kumpulan 5% CSPFAD.

Sebagai kesimpulan, CSPFAD boleh digunakan sehingga 5% sebagai sumber tenaga di dalam diet tanpa sebarang kesan mudarat ke atas fermentasi rumen, disamping dapat memperbaiki kualiti daging seperti kelembutan.

ACKNOWLEDGEMENTS

I would like to express my deep appreciation and profound gratitude to my supervisors, Professor Dr. Abdul Razak Alimon, Associate Professor Dr. Halimatun Yaakub and Dr. Awis Qurni Sazili for their guidance, encouragements and advice throughout my study.

I would like to express my gratitude to the staff of the laboratory of nutrition lab. Saparin bin Demin, Ibrahim bin Moshin and Abdul Halin bin Mohamed Isa Department of Animal Science.

I would like to express my gratitude to the all of postgraduate students especially Mr. Zelealem, Mr Riyadh, Mr. Mustaffa, Mr Boddy, Ms. Devika. Ms Nwe, Ms. Elizabeth and Ms. Lai Pui Wah for their collaboration, help and encouragements.

Finally, my deepest gratitude and respect to my parents for their support, guidance, encouragements and advice and to our leaders YASSER ARAFAT and AL-SHAIKH AHMED YASSEN.

I certify that an Examination Committee met on 13th September 2005 to conduct the final examination of Imad N. H. Al-Waheidi on his Master of Science thesis entitled "Effects of Calcium Salt of Palm Fatty Acid Distillate on the Growth, Rumen Parameters and Meat Quality of Sheep" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisor Committee are as follows

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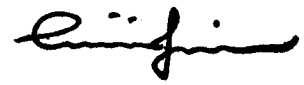

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously concurrently submitted for any other degree at UPM or other institutions.

alwaheidi

IMAD NEMER HASSEN ALWAHEIDI

Date: 20/10/2005

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LIST OF ABBREVIATIONS

ADG	—	Average daily gain
ANOVA	—	Analysis of variance
AOAC	—	Association Official Analytical Chemists
BW	—	Body weight
°C	—	Celsius degree
CP	—	Crude protein
CRD	—	Complete randomized design
CSPFAD	—	Calcium salt of palm fatty acids distillate
d	—	Day
DM	—	Dry matter
EE	—	Ether extract
EFB	—	Empty fruit branch
FA	—	Fatty acids
FCR	—	Feed conversation ratio
g	—	Gram
GC	—	Gas chromatography
H	—	Hour
Kg	—	Kilogram
L	—	Liter
LD	—	Longissmus dorsi
mg	—	Milligram

min	—	Minute
mmol	—	Millimole
MPOB	—	Malaysian Palm Oil Board
NH_3-N	—	Ammonia nitrogen
NRC	—	National Research Council
OPF	—	Oil palm frond
P	—	Probability
PKC	—	Palm kernel cake
POME	—	Palm oil mill effluent
POS	—	Palm oil sludge
PUFA	—	Polyunsaturated fatty acids
SAS	—	Statistical Analysis System
SD	—	Standard deviation
SEM	—	Standard error of mean
t	—	Time
UPM	—	Universiti Putra Malaysia
VFA	—	Volatile fatty acids
Wt	—	Weight
$W^{0.75}$		Metabolic body weight

CHAPTER 1

INTRODUCTION

Among ruminants, sheep constitute, in many countries, an important group of animals supplying man with necessary meat, leather, wool and dairy products. They are important protein suppliers. A leading position of sheep among the cheap protein producers is explained by the fact that they can live everywhere where there is any vegetation and the development of this group of animals is a consequence of fodder availability (Jaroslaw, 1999). Livestock production is developing very fast in most parts of Asia, driven by an increased demand. The increase of livestock production is mainly supported by industrial systems, with series of environmental impacts, among which nutrient overloads is probably the most severe (Menzi, 2001).

Animal production system in Malaysia is very similar to that found in many parts of Southeast Asia. The majority comprises smallholdings but there are some large scale operators, particularly in the non-ruminant sector. And it can be described as extensive, intensive, semi-intensive and animal tree-crop integration system (Jalaludin *et al.*, 1998). During the last 20 years, ruminants have been introduced in rubber and oil palm plantations, especially in the land development schemes. Although the concept of integrating ruminant production to the plantations is

theoretically feasible and profitable, only a few plantations have adopted this practice. Goats and sheep rearing are scattered throughout the country and the rearing of these animals has always been a subsidiary activity of farmers in rice growing areas and workers in rubber and oil palm plantations. Sheep population in Malaysia has shown an increased trend over the last 30 years (Appendix A).

Malaysia since long time ago has been the largest producer of palm oil with the area expanded from 300,000 ha in 1970 to 3.5 million ha in 2001 (MPOB, 2001). Palm oil is second to soybean oil in world of vegetable oils, and makes up more than half of total oil exports (Gunstone, 2003).The main four by-products from palm oil are PPF (palm press fiber) which come from fibrous of oil palm fruits after oil extraction, PKC (palm kernel cake) which is derived from solid residue obtained following the extraction of oil from the kernel of the palm fruit, oil palm fronds (OPF) which come from palm trees require regular pruning to facilitate harvesting of mature fruit and POME (palm oil mill effluent) (Jalaludin *et al.*, 1991). Palm fatty acid distillate (PFAD), a by-product of palm oil refining, makes up approximately 5% of the 28 million tonnes of palm oil expected to be produced in 2004. Palm fatty acid distillate is an attractive ingredient as a fat supplement for livestock; it is readily available, relatively stable to oxidant rancidity and inexpensive. Prices have been decreased in recent years. Its use has continued to increase as fatty acids as hydrogenated fatty acids or as calcium salt of fatty acids.

From the literature it may be concluded that the greatest use of PFAD is in ruminant diets, especially dairy, either as hydrogenated fatty acid or as calcium salt of fatty acid, rather limited information is available on the use of palm oil diets in beef cattle, sheep fatness, chicken and pigs no information was found from a search of literature for using palm oil in horse, dog or cat diets (Palmquist, 2004).Fat supplements are included in the diet of ruminants to increase energy density improve nutrient utilization, enhance meat yields and manipulate fatty acid composition (Coppock and Wilks, 1991). However fat has an inhibitory effect on rumen microorganism. In the rumen, the unsaturated fatty acid is converted to saturated fats through hydrogenation. The negative effects of fats on rumen function can be partially over come by adding sources of cations such as limestone, calcium from insoluble calcium soap with fatty acid which will prevent them from inhibiting rumen microbes. (Schneider *et al.*, 1988). Based on the finding of Castro *et al* (2005) vegetable fats such as palm oil can be included to the diet in the form of calcium salt of fatty acid in fattening lambs without altering carcass characteristics.

1.1 General objectives

The general objective of this study was to evaluate the effect of Calcium salt of palm fatty acid distillate (CSPFAD) supplementation on the growth, rumen parameters and meat quality of sheep.

Specific objectives:

- To investigate the effect of CSPFAD on growth performance in sheep.
- To investigate the effect of CSPFAD supplementation on rumen volatile fatty acid and fiber digestion.
- To investigate the effect of CSPFAD on carcass characteristics and meat quality of sheep.

CHAPTER 2

LITERATURE REVIEW

2.1 Feeds from palm oil industry

The oil palm industry offers a number of opportunities in terms of feed resources which can be utilized for animal production. These feed resources included forage growing in the inter-rows of the plantation to the oil extraction by-products from palm oil mills. Many of these by-products, for example palm kernel cake (PKC) are rich in nutrients and have been proven to be high quality feeds for ruminants. Integrating animals with oil palm plantations will ensure long term profitability as well as sustainability of the agriculture industry in a very good competitive environment.

2.2 Palm oil

Palm oil is available in about 15 different grades, ranging from crude to semi-refined, and refined, crude fractionated, refined fractionated oil and refinery by-products. Palm oil is currently the main fat source in feeds for monogastric animals. However, it is not commonly fed to ruminants because it can result in rumen disorders, metabolic problems and reduced milk fat content (Palmquist, 1995). On the other hand, calcium soaps of palm oil origin given to high producing dairy cattle to increase energy intake, produced many positive effects as an energy supplement (Palmquist, 1995). This is attributed to the high level of unsaturated

fatty acids which escape rumen degradation and leading to enhance digestibility. This makes calcium soaps of palm oil origin a good source of rumen-protected energy.

2.3 Oil palm by-products

The oil palm industry produces by-products that can be used as animal feeds. In the plantation oil palm fronds are regularly pruned to facilitate the harvesting of fruits. At the oil palm mills by-products such as empty fruit bunches, palm press fibre, palm kernel cake and palm oil mill effluent are produced. These by-products, with proper processing can be utilized as feed for ruminants. From the oil refining plant by-products such as palm fatty acid distillates, fatty acids and glycerol are produced. These by-products are valuable in the oleo-chemical industry and can also be used as energy sources for ruminants.

2.3.1 Palm press fibre (PPF)

Palm press fiber (PPF) is a fibrous residue following oil extraction from the mesocarp of the palm fruits. The potential of using PPF for ruminant production is enormous but, due to its bulkiness and low feeding value, the amount consumed and digested is inadequate to support production at an economic level. Therefore,

the use of PPF can be enhanced by improving its nutritive value by chemical treatment and manipulation of the ration to optimize rumen fermentation. Treating PPF with chemicals such as sodium hydroxide, urea and ammonium hydroxide has resulted in varying degrees of improvement in feed intake and biodegradability. For example, dry matter digestibility (DMD) increased from 43.3% to 58.0% when PPF was treated with 8% sodium hydroxide (Jelan *et al.,* 1986). Buffalo could be induced to

increase voluntary intake of PPF which was sprayed with molasses and supplemented with fish meal. Animals fed urea-treated PPF had significantly higher voluntary feed intake when energy and protein were supplemented compared to those receiving only protein or energy (Jalaludin *et al.,* 1991).

2.3.2 Palm kernel cake (PKC)

In Malaysia, more than 2.0 million tonnes of PKC are produced annually. PKC has a fairly high nutritive value and is being used extensively for fattening steers in feedlots. The crude protein content of PKC ranges from 16 to 18.7% depending on processing methods and the degree of impurities such as shell content. At 70% DMD, PKC is readily consumed by both small and large ruminants (Alimon and Hair Bejo, 1995; Alimon, 2004). Hutagalung (1985) reported that dairy cattle fed 6-8 kg of PKC combined with small quantities of feed additive (e.g., minerals and vitamins) produced daily growth rates of 0.7-1.0 kg/animal. Similar results were obtained under farming conditions by (Jelan *et al.,* 1986).